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Student nurses' knowledge and skills of children's environmental health: Instrument development and psychometric analysis using item response theory

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ABSTRACT

Background: Climate change has an important impact on health, particularly in children. Therefore, the inclusion of environmental issues in the undergraduate nursing curriculum is essential. Knowledge and skills in environmental sustainability can be measured through questionnaires.
Objectives: The aim of this study was to develop and validate the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q) to measure knowledge and skills, respectively, about children's environmental health in nursing students.
Design: This was an observational, cross-sectional study undertaken in four phases: (1) Development of the questionnaire and item wording, (2) content validation by an expert panel, (3) pilot test and (4) psychometric evaluation.
Settings: A Faculty of Health Sciences in Spain.
Participants: 308 nursing students enrolled in the first, third and fourth years of study.
Methods: The development and validation of the children's environmental health questionnaires was carried out based on the item response theory.
Results: The 26-item ChEHK-Q shows good fit and reliability of 0.98 for items and 0.70 for people based on the Rasch Model. The 12-item ChEHS-Q also shows good fit and reliability of 0.87 for items and 0.76 for people based on Andrich's rating scale model. The temporal stability measured using the intraclass correlation coefficient was 0.86 in the ChEHK-Q and 0.73 in the ChEHS-Q. Both questionnaires present enough evidence for construct validity; they work well to distinguish between nursing students with low or high knowledge of or skills in children's environmental health.
Conclusions: The Children's Environmental Health Knowledge Questionnaire and the Children's Environmental Health Skills Questionnaire are useful tools for measuring knowledge and skills, respectively, among nursing students. This validation study obtained good psychometric properties concerning validity and reliability.

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1. Introduction

Climate change has had important impacts on health, because it threatens clean air, the safe consumption of water, the provision of food, and safe housing, increases temperatures and affects social dimensions (Nicholas and Breakey, 2017; Sullivan-Marx and McCauley, 2017).

Children, especially those under five years, comprise a population that is vulnerable to negative health effects (Sullivan-Marx and McCauley, 2017). Due to the combined effects of development, physiology, diet and their specific behaviors, children may experience higher levels of exposure to toxins than adults. Moreover, children are at a greater risk for heat illness, insect transmission, malnutrition, diarrhea and asthma (Leffers et al., 2017).

2. Background

As suggested by Anaker and Elf (2014), environmental awareness is very important in the nursing field, because nurses, as health care providers, scientists, educators and leaders, have an obligation to prepare for climate change and other environmental impacts on health (Kurth, 2017; Leffers et al., 2017; López-Fernández et al., 2000).

A lot of nursing organizations are currently developing guidelines on climate change that are especially focused on training healthcare professionals about climate change, the vulnerability of children (Kurth, 2017; López-Fernández et al., 2000; Nicholas and Breakey, 2017; Sullivan-Marx and McCauley, 2017) and the prevention of illnesses caused by environmental risks. This is an important point because many nurses are unable to integrate environmental health into their daily routine (Kurth, 2017; Leffers et al., 2017).

Universities play a leading role in creating educational solutions to problems associated with sustainable development (Álvarez-Nieto et al., 2017; Sullivan-Marx and McCauley, 2017). However, according to Kirk (2002), nursing students are being poorly prepared regarding the understanding of connections between climate change, sustainability and health. At present, there is a growing need to include sustainability and climate change in the nursing curriculum (Goodman and Richardson, 2010; López-Fernández et al., 2000).

Therefore it becomes necessary to include environmental issues in undergraduate nursing education and tools to evaluate its effectiveness in increasing children's environmental health knowledge and skills. Leffers et al. (2017) collected ten recommendations to include climate change in nursing education.

In the absence of such measuring instruments, the objective of this study is to develop and validate two new tools, the Children's Environmental Health Knowledge Questionnaire (ChEHK-Q) and the Children's Environmental Health Skills Questionnaire (ChEHS-Q), that allow to assess the knowledge and skills in children's health and environment of nursing students.

3. Methods

The research constituted an observational, cross-sectional study to validate the ChEHK-Q and the ChEHS-Q. The development and validation of the children's environmental health questionnaires was carried out based on the item response theory, the Rasch model for the ChEHK-Q and Andrich's rating scale model for the ChEHS-Q (Meyer, 2014). This research included four phases, as follows:

3.1. Phase 1: Development of the Questionnaire and Item Wording

First, a literature review was carried out in order to develop the questionnaires.

3.1.1. Knowledge Questionnaire

Following Hernández-Sampieri et al. (2010), the ChEHK-Q was built using a matrix where the variable (knowledge of environmental health) was moved to its dimensions, then to indicators and finally to 55 knowledge items. Each item has three response options (True/False/Don't know).

3.1.2. Skills Questionnaire

As recommended by Morales-Vallejo (2010), the initial 19-item ChEHS-Q statements were worded in both positive and negative directions. Each item is measured using a Likert scale with values from 1 (*strongly disagree*) to 5 (*strongly agree*).

We used the Flesch-Szigriszt formula using the Inflesz scale for readability in Spanish (Barrio-Cantalejo et al., 2008). For the ChEHK-Q 29 items were removed after using this test, resulting in a 26-items second version with a Flesch-Szigriszt readability index of 62.02 (*normal difficulty*). For the ChEHS-Q, 7 redundant items were deleted, resulting in a 12-items version that showed a Flesch-Szigriszt readability index of 53.80 (*somewhat difficult* but suitable for our population).

3.2. Phase 2: Content Validation by an Expert Panel

A 6 expert panel was formed for content validation. The experts were university teachers, researchers, clinical nurses and psychologists with previous knowledge and experience in questionnaire development and environmental health. In a preliminary phase, the experts evaluated the relevance and clarity of the items in the second version of the questionnaires using a prioritization method by the nominal scale technique (Pineault and Daveluy, 1987). Then, they assessed the understanding, appropriateness for the target population and the consistency of the items within the dimension in which they were included. They were asked to include new items when necessary. In the evaluation phase, we calculated the Aiken's V coefficient, setting Vo = 0.80, and a confidence interval value of 0.60 in its lower threshold as the minimum acceptable value (Charter, 2003). In the discussion phase, all of the experts' opinions were shared, asking them about the items with great disagreement.

In this way, we were obtained the third versions of each questionnaire. In the ChEHK-Q, two items were removed and another six which had been proposed by experts were added, so the third version of ChEHK-Q also had 30 items. In the ChEHS-Q, the 12 items were retained. Upon attaining expert consensus, a cognitive piloting was carried out with 12 nursing students in which they had to fill in the two questionnaires and answer three open questions about the understanding and questionnaires format. Finally, the wording of some items in both questionnaires was amended following the expert and students´ suggestions.

3.3. Phase 3: Pilot Test

The target population was 153 nursing students who were enrolled in a Child and Adolescent Nursing course. For data collection, each student accessed the questionnaires individually through Google® forms in a university computer classroom from March to April 2016.

The difficulty index (Cohen and Swerdlik, 2000), discrimination index (Morales-Vallejo, 2009) and inter-item and item-total correlations using Pearson's coefficient were calculated in ChEHK-Q. Inter-item and item-total correlations were calculated in ChEHS-Q. With these tests, we developed the fourth versions of the questionnaires. Items with negative discrimination values were removed. Items with discrimination under 0.30, very easy, very difficult and those with negative correlations were reworded. Thus, in the ChEHK-Q case, 2 items were removed and 16 were reworded, leaving the questionnaire with 28 items. The ChEHS-Q stayed unchanged, with 12 items.

3.4. Phase 4: Psychometric Evaluation

The population used for the psychometric evaluation was undergraduate nursing students (first, third and fourth year). The sample size was estimated to be at least 280 (for the 28-item version of the questionnaire), according to the methodological recommendations for the validation of questionnaires, namely 10 individuals per item (Polit and Beck, 2008). Data collection was carried out in classes of different subjects of the Nursing Degree. To complete the questionnaires, each student could access them online or complete them in paper format. Data collection took place in September 2017.

The psychometric analysis of the questionnaires was carried out using one parameter models based on item response theory, which is based on three assumptions. First, the one-dimensionality of the questionnaires was checked, as suggested by Jiménez-Alfaro and Montero-Rojas (2013), through an exploratory factorial analysis of each questionnaire; it was found that both questionnaires were one-dimensional. Second, local independence was also checked, using Yen's Q3 statistic. In ChEHK-Q, the higher value was 0.26 and in ChEHS-Q only one value was −0.38 while the other values did not exceed ± 0.30. Therefore, they were not considered an important independence problem since the values did not exceed ± 0.20 by far (Meyer, 2014). Third, the Rasch Model analyzed the parameters of subjects (θ) and items (β) in the variables of knowledge and skills, which were shown in an item map. The infit and outfit statistics were used to fit the data to the model (optimal fit values ranged from 0.8 to 1.2). The Rasch model calculated the difficulty of the items, with 0 being the mean level of difficulty. It also considered the separation index, and separation values are ideally larger than 2 (Meyer, 2014). An internal consistency value of 0.70 or higher (Nunnally and Bernstein, 1995) was considered acceptable for the reliability analysis in the Rasch model; these values were calculated for items and subjects. The ChEHS-Q was analyzed using Andrich's rating scale model, which is based on the same assumptions and parameters as the Rasch model. In addition to item (mis)fit, this model analyzed threshold ordering by inspecting estimated threshold locations along the latent trait, because the disorder of thresholds may indicate the inappropriate functioning of response categories. The missing data was random, then they was ignored by performing data imputation to replace them. These analyses were conducted using jMetrik software.

Temporal stability was assessed using the test-retest procedure, estimating the Intraclass Correlation Coefficient (ICC) and its 95% Confidence Interval. A group of 21 students completed the questionnaires twice over a two-week interval. The value of 0.70 was set as an acceptable minimum for this coefficient (Hernández-Sampieri et al., 2010).

Construct validity was tested through exploratory factorial analysis (EFA). Horn's parallel analysis was used with a Monte Carlo simulation for a principal component analysis using the Monte Carlo PCA® software, because this method has been shown to have the least variability and the best sensitivity (Ledesma and Valero-Mora, 2007). Furthermore, we tested the discriminatory validity with a hypothesis in known groups (groups with expected high and low knowledge and skills on environmental health), comparing students who had attended an educational session on environmental health with those who had not. Comparisons of mean knowledge and skill scores were undertaken using suitable tests of mean differences.

3.5. Descriptive Analysis

We calculated univariate descriptive values. In ChEHK-Q, we calculated the percentage of correct answers and the ignorance index to determine the proportion of people who answer “I Don't Know” for each item of the knowledge questionnaire.

Using the total scores and number of items in the questionnaires, the ratio was calculated to categorize the questionnaire scores.

Table 1
Demographic characteristics of the sample (n = 308).

Characteristics	n	%
Age (Mean/SD)	21.87	6.19
Gender		
Male	56	18.20
Female	250	81.20
Year of course		
First	113	36.70
Third	102	33.10
Fourth	83	26.90
Have attended a session on sustainability and nursing		
Yes, within three months	15	4.90
No	215	69.80
Yes, but over three months ago	73	23.70

3.6. Ethic

This study was approved by the Committee of Research Ethics of the university. An information sheet was developed for participants to provide information on the research scope. Students were not obliged to fill out the questionnaires, and it did not affect the mark of any subject that they were studied. Informed consent was signed for participation in this study and its design was in accordance with the Spanish Law of Data Protection. The data collection was performed by a PhD student and the questionnaires were self-administered and anonymous. The confidentiality of their personal data was guaranteed.

4. Results

4.1. Participant Characteristics

The sample comprised 308 nursing students enrolled in the first, third and fourth years of study. Table 1 shows the main characteristics of this sample.

4.2. Children's Environmental Health Knowledge Questionnaire

4.2.1. Rasch Model Children's Environmental Health Knowledge Questionnaire

In the Rasch model, the items showed central values at 1 for infit and outfit, verifying the one-dimensionality of the construct. In Table 2, where individual items values are shown, items 6, 7, 23 and 27 slightly overfit (without being > 1.3 for outfit). In order to assess the removal of items, they were represented in an items map (Fig. 1); items 1 and 6 were removed, since they were the easiest and were below the ability level of the sample subjects, meaning that they were useless to discriminate between subjects. Items 7, 23 and 27, although they showed slight differences from the set parameters, were considered essential to measure the construct. In the case of items 7 and 23, they identify subjects with high ability for the latent trait, and item 27 was found to be in the mean of discrimination, so it has a suitable quality to classify the subjects. In the final 26-item questionnaire, the mean for the infit was 1.002 (0.875 to 1.160) and the mean for the outfit was 0.996 (0.840 to 1.262). The difficulty values range from −1.75 for the easiest items (item 2: “The pediatric population is more susceptible to environmental threats due to their biological immaturity.” and item 26: “Schools and nurseries are environmentally safe places”), to 2.66 for the most difficult (item 21: “The major source of childhood exposure to pesticides is through ambient air.”). The item separation index was 7.45 and the people separation index was 1.53. The reliability value for the items was 0.98 and for the people was 0.70. These values show the strength of the items to adequately rank order people on the latent trait, although with some restrictions on the sample subjects.

Table 2
Parameters of the ChEHK-Q Rasch model.

Item	Difficulty (SE)	Infit	Outfit
1. Exposure to environmental risks during childhood determines an individual's potential years of life.	−2.88 (0.30)	0.98	0.83
2. The pediatric population is more susceptible to environmental threats due to their biological immaturity.	−1.75 (0.19)	0.97	0.94
3. The increased energy and metabolic consumption of the pediatric population protects children from environmental hazards.	0.27 (0.12)	0.95	0.96
4. The higher rate of cell growth during the pediatric age increases the risk of health effects caused by environmental factors.	−0.18 (0.13)	1.00	0.96
5. Environmental factors do not influence hormonal secretion during puberty.	−0.74 (0.14)	0.96	0.86
6. Chronic exposure to volatile organic compounds (from cleaning products or paints) may cause cancer.	−2.33 (0.24)	1.05	**1.23**
7. Nitrogen oxide from fossil fuels in the home and tobacco smoke causes redness and burns on the skin.	2.36 (0.16)	1.17	**1.28**
8. Particles from animals exacerbate asthma crisis.	−0.18 (0.13)	0.98	0.94
9. Increased humidity at home improves respiratory diseases in children.	0.50 (0.12)	1.05	1.07
10. Passive smoking is associated with the development of acute leukemias in children.	0.78 (0.12)	1.03	1.06
11. Childhood leukemia incidence rates are higher in the areas most exposed to radon.	−0.18 (0.13)	0.91	0.87
12. Overexposure to solar ultraviolet radiations can damage the skin of adults more severely than that of children.	−0.52 (0.14)	0.87	0.82
13. During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed.	0.84 (0.12)	0.97	0.98
14. Lead accumulates in the body affecting the nervous system.	−0.75 (0.14)	0.87	0.82
15. Chronic dietary exposure to mercury (fish and shellfish) is less toxic to children's central nervous system than to adults.	−0.44 (0.13)	0.99	0.98
16. Exposure to pesticides increases the risk of developing attention deficit problems in school-aged children.	0.61 (0.12)	0.91	0.88
17. Children born to smoking mothers during pregnancy are at risk of lower intellectual capacity.	−0.46 (0.13)	1.01	0.96
18. Exposure to organic solvents during fetal development can cause learning disabilities in children.	−0.20 (0.13)	1.00	0.98
19. Water containing nitrates can only cause intoxication during childhood.	−0.13 (0.13)	1.04	1.01
20. Chlorination of water forms sub-products from the disinfection process that have been classified as carcinogenic.	0.70 (0.12)	0.99	0.97
21. The major source of childhood exposure to pesticides is through ambient air.	2.66 (0.17)	1.04	1.08
22. The main route of exposure to mercury is through cereal intake.	0.34 (0.12)	1.08	1.08
23. Exposure to lead through diet occurs mainly through fish intake.	2.26 (0.15)	1.12	**1.24**
24. Food colorings and preservatives are associated with central nervous system problems.	0.84 (0.12)	0.89	0.86
25. Genetically modified foods cause fewer allergic reactions in children.	0.04 (0.13)	0.95	0.94
26. Schools and nurseries are environmentally safe places.	−1.75 (0.19)	0.98	0.89
27. Children are exposed to higher concentrations of air pollutants at home than outdoors.	0.14 (0.13)	1.13	**1.21**
28. Parks and gardens are the areas with the least environmental pollutants where children can play.	0.17 (0.12)	1.05	1.03

Note. Values exceeding the limits set for infit and outfit (0.80–1.20) are in boldface. SE = standard error. Infit = Weighted Mean Square Fit; Outfit = Unweighted Mean Square Fit.

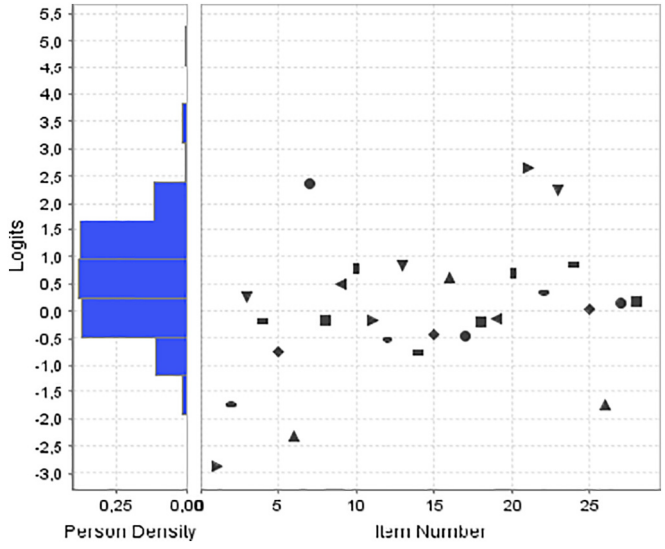

Fig. 1. ChEHK-Q item map [on the left the level of latent trait of the participants (θ); on the right the difficulty of the items (β)].

4.2.2. Temporal Stability

The test-retest reliability of the ChEHK-Q, using the ICC was 0.86, 95% CI [0.66, 0.94].

4.2.3. Construct Validity

The EFA, after Horn's parallel analysis to compare the explained values of variance with those obtained in the simulation, found only one meaningful factor. The scree test also showed an inflection below the first factor. In addition, none of the EFA model showed good values of explained variance, nor did the items exhibit an adequate fit to a theoretical model, so the questionnaire was found to be one-dimensional.

We hypothesized that the scores obtained with the ChEHK-Q would be higher in some students who had attended an educational session on environmental health beforehand would have greater knowledge than those who had not. The Student's *t*-test was used to confirm this hypothesis, since the data were normally distributed (Table 3). The scale is able to differentiate correctly between people with high and low knowledge.

4.2.4. Descriptive Analysis

In the final 26-item ChEHK-Q, the maximum score is 26 points. The mean score was 15.19 (SD = 4.08). Items 1 ('The pediatric population is more susceptible to environmental threats due to their biological immaturity') and 24 ('Schools and nurseries are environmentally safe places') were the ones that had the highest percentage of correct answer (89.3%), while item 19 ('The major source of childhood exposure to pesticides is through ambient air') had the lowest (14.6%). The most unknown items were 8 ('Passive smoking is associated with the development of acute leukemia in children') and 11 ('During childhood more than half of the expected lifetime solar ultraviolet radiation is absorbed'), with an ignorance index of 43.20%.

Based on the present analysis (ChEHK-Q results), a score ranging knowledge categorization (from 0 to 100) was proposed as follows: excellent knowledge (> 90% correct answers), 4 sample participants; very good knowledge (90–80% correct answers), 27 sample participants; good knowledge (80–60% correct answers), 116 sample

Table 3
Construct validity of ChEHK-Q, comparing known groups with high or low expected level of children's environmental health knowledge.

Have attended a session on sustainability and nursing	Score in the scale mean	Standard deviation	Student's *t*-test statistic	p-Value
Yes (n = 88)	16.69	3.60	4.12	<0.001
No (n = 215)	14.61	4.14		

Table 4
Parameters of the ChEHS-Q rating scale model.

Item	Difficulty (SE)	Infit	Outfit
1. I am able to assess the main environmental risks to which a child is exposed.	−0.25 (0.07)	**1.22**	**1.22**
2. I am NOT able to identify the environmental risks that can cause respiratory diseases in a child.	−0.08 (0.07)	1.15	1.15
3. I am able to identify the environmental risks that can cause neoplastic diseases in a child.	0.12 (0.07)	0.95	1.02
4. I am NOT able to identify the environmental risks that can cause neurological disorders in a child.	0.05 (0.07)	0.95	1.01
5. I am able to provide health education to parents about the main contaminants in their child's food.	0.25 (0.06)	0.89	0.95
6. I am NOT able to identify the environmental risks in playgrounds.	−0.01(0.07)	0.97	0.98
7. I am able to provide health education to parents about actions to minimize environmental risks to which a child is exposed when playing outdoors.	<0.01 (0.07)	1.03	0.98
8. I am NOT able to identify the environmental risks in a child's home.	<-0.01 (0.07)	0.99	0.98
9. I am able to provide health promotion to parents about environmental risks at home.	−0.03 (0.07)	0.81	**0.74**
10. I am able to identify the environmental risks in a child's school.	−0.28 (0.07)	0.94	0.98
11. I am NOT able to identify the actions needed to combat environmental risks in a child's school.	−0.16 (0.07)	0.95	0.88
12. I do NOT feel able to do my job as a nurse in a Pediatric Environmental Health Specialty Unit.	0.40 (0.06)	1.16	1.19

Note. Values exceeding the limits set for infit and outfit (0.80–1.20) are in boldface. SE = standard error. Infit = Weighted Mean Square Fit; Outfit = Unweighted Mean Square Fit.

participants; not enough knowledge (60–40% correct answers), 120 sample participants; and poor knowledge (< 40% correct answers), 41 sample participants. The data show that 147 students had at least good knowledge, but a slightly higher number of students (161) did not reach an adequate level of knowledge in children's environmental health.

4.3. Children's Environmental Health Skills Questionnaire

4.3.1. Andrich's Rating Scale Model

In the ChEHS-Q model (Table 4), item 1 slightly overfit (1.22 for both infit and outfit) and item 9 obtained an outfit value that was slightly lower (0.74). In order to assess the items functioning, they are shown in Fig. 2. Most of the items are located in the region with most examinations. Because of the relationship between item difficulty and the standard error of the ability estimates, completing this questionnaire will be measured with an adequate amount of precision. Mean infit value was 1.002 (0.813 to 1.220) and mean outfit value was 1.007 (0.738 to 1.221). Difficulty values ranged from −0.28 for the easiest item (item 10: 'I am able to identify the environmental risks in a child's school') to 0.40 for the most difficult (item 12: 'I do NOT feel able to do my job as a nurse in a Pediatric Environmental Health Specialty Unit'). The separation items index was 2.62 and the separation people index was 1.79. The item separation was strong, but the people separation showed some restrictions, as in ChEHK-Q. The reliability for the set of items was 0.87 and for people it was 0.76, being suitable in both cases; however, it was also higher in the case of the items than in the case of the people.

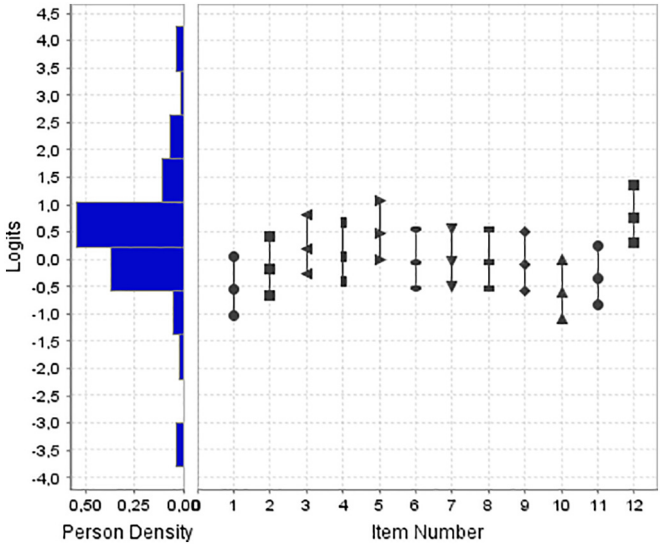

Fig. 2. ChEHS-Q item map [on the left the level of latent trait of the participants (θ); on the right the difficulty of the items (β)].

Table 5
Statistics of Likert categories ChEHS-Q rating scale model.

Likert category	Threshold	Standard deviation	Infit	Outfit
0				
1	−0.04	0.05	0.86	0.82
2	−0.52	0.04	0.84	0.88
3	0.56	0.04	1.10	1.11

In Table 5, the thresholds on the ChEHS-Q Likert scale ranged from a low of −0.04 to a high of 0.56, increasing their value progressively on the scale, and there were no reversals. Although it seems that these thresholds do not cover much of the latent scale, these items actually span the latent scale from −3.80 to 4.26 when converted to step parameters by adding thresholds to item difficulty. The fit of these categories is good with all category infit and outfit values close to 1.

4.3.2. Temporal Stability

In the test-retest reliability analysis, the ICC between the two administrations was 0.73, 95% CI [0.34, 0.89].

4.3.3. Construct Validity

Both the Horn's parallel analysis and the scree test oriented to extract two factors in the EFA. An EFA forced to 2 factors with Varimax rotation was performed explaining a 54.08% of the variance; however this 2-factors model had no theoretical justification since only items worded in positive or negative direction were grouped. Therefore, the ChEHS-Q was also found to be one-dimensional.

We hypothesized that the scores obtained with the ChEHS-Q would be higher in some students who had attended an educational session on environmental health. The Mann-Whitney *U* test was used to confirm this hypothesis, since the assumption of normal distribution was violated (Table 6). The scale is also able to differentiate correctly between people with high and low skills.

Table 6
Construct validity of ChEHS-Q, comparing know groups with high or low expected level of children's environmental health skills.

Have attended a session on sustainability and nursing	Score in the scale mean	Standard deviation	U de Mann-Whitney	p-Value
Yes (n = 86)	36.17	3.80	6488.00	0.001
No (n = 202)	34.68	3.74		

4.3.4. Descriptive Analysis

In ChEHS-Q, the maximum score is 60 points. The average score was 41.10 (SD = 7.61). All of the item means were similar, highlighting item 1 ('I am able to assess the main environmental risks to which a child is exposed') as the one with the highest perceived skill (3.63, SD = 0.85) and item 3 ('I am able to identify the environmental risks that can cause neoplastic diseases in a child') as the one with the lowest perceived skill (3.05, SD = 0.99).

Similarly to the knowledge questionnaire, based on the present analysis (ChEHS-Q results), a score ranging skill categorization (from 0 to 100) was proposed as follows: excellent skills (> 90% perceived skills), 18 sample participants; very good skills (90–80% perceived skills), 42 sample participants; good skills (80–70% perceived skills), 78 sample participants; not enough skills (70–50% perceived skills), 146 sample people; and poor skills (< 50% perceived skills), 24 sample participants. The data show that 138 students had at least good skills, but a higher number of students, 170, did not reach an adequate level of skills in children's environmental health.

5. Discussion

This research has focused on the development and validation of two new tools to measure knowledge of and skills in children's environmental health for nursing students. Both questionnaires have good content validity based on a robust process of review by an expert panel. They also show suitable psychometric characteristics. The ChEHK-Q is designed as a 26-item questionnaire and the ChEHS-Q is a 12-item questionnaire; both can be easily used online or on paper by self-administration. Both tools are one-dimensional, producing a total score to measure the amount of knowledge of or skills in children's environmental health just by adding up the number of correct answers in ChEHK-Q or by adding up the scores obtained on the Likert scale in ChEHS-Q. We consider that this one-dimensional structure is advantageous, because it has just one score and is easy to use. The questionnaires could be obtained through the project website (source deleted for blinded review).

For the psychometric analysis, we used item response theory because it makes strong assumptions and therefore gets results that are stronger than those of the classical measurement theory (Navas, 1994). Our intention was to develop a final version of the questionnaires able to measure the latent traits 'knowledge of children's environmental health' and 'skills in children's environmental health' among nursing students, so we needed to include items with different levels of difficulty. Through the item analysis, some of the very easy items in ChEHK-Q were deleted because they made no contribution to the discriminant capacity of the scale. Although some items had infit and outfit values that were higher than the conservative values we established, they do not exceed values between 0.7 and 1.3, which are those set by other less restrictive authors (Blackman and Giles, 2015; Boone, 2016). Therefore, analysis with the Rasch model confirmed that ChEHK-Q has a good fit and has items with different levels of difficulty, and analysis with the Andrich's rating scale model confirmed that ChEHS-Q has also a good fit. In addition, the parameters of the models of both questionnaires reveal the strength of the items, although with some restrictions in the sample population. This could be due to the size and homogeneity of the sample, so it is proposed for future studies to increase the sample with nursing students from other universities, even from different countries.

Our research also provides evidence of construct validity for both questionnaires. The measures of knowledge and skills produced by these news questionnaires appear to be stable over time.

Descriptive analysis showed that there are a large number of nursing students with good knowledge and skills in children's environmental health, but there are also a greater number who need to improve their knowledge and above all their skills for dealing with this issue. However, the sampling was not random and there is a possibility that students with more motivation, knowledge or skills have completed the survey, so this could lead to an overestimation in the results. Future research may be aimed at the use of these questionnaires to determine whether the inclusion of issues related to children's environmental health problems in the nursing curriculum is associated with an increased score in these questionnaires. The promotion of such studies may help to determine which learning and teaching methods are more effective to increase the knowledge and skills of nurses with regards to problems in children's environmental health. Also, in pediatric nurses working in healthcare centers, ChEHK-Q and ChEHS-Q could be used to determine their knowledge of and skills in children's environmental health, before and after initiatives to increase their training in this area.

The ChEHK-Q and the ChEHS-Q are the first tools developed and applied for measuring knowledge of and skills in children's environmental health. We have not found any scale to measure these concepts (knowledge of and skills in children's environmental health) to use as a gold-standard for criterion validity evaluation. However, we did find the study by Richardson et al. (2016) which developed a questionnaire to assess the attitudes of nursing students from four European countries on the inclusion of environmental sustainability in nursing curriculum. The increased awareness of nurses' attitudes towards sustainability provided by this study supports the development and evaluation of sustainable teaching and learning materials to increase environmental health knowledge and skills.

Álvarez-Nieto et al. (2018) evaluated the quality of education materials for nursing and sustainability; in this case, the ChEHK-Q and the ChEHS-Q would be useful for assessing knowledge and skills before and after the educational sessions. This could be considered in future studies.

In 2015, Richardson et al. also showed that a skills session on climate change and sustainability improved nursing students' knowledge, by evaluating them three months after the session (Richardson et al., 2015). Another study by Richardson et al. (2014) held a clinical skills session in nursing students from the Plymouth University in order to introduce sustainability issues using new information technologies to carry out a discussion about them. The knowledge learnt by students was assessed, finding a greater awareness in all students about waste management in healthcare.

This research provides a significant reflection on learning processes in the current educational system and how to improve it through the implementation of environmental sustainability within the context of the European Higher Education Area. University nursing training should include environmental issues, both conceptually and practically, and both transversally and specifically. The use of the ChEHK-Q and the ChEHS-Q may help to guide the teaching-learning process in children's environmental health higher education.

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Declarations of Interest

None.

Ethic

This study was approved by the Committee of Research Ethics of Universidad de Jaén.

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